

## CLAIMS

1. A combination comprising:

a read head including:

a read sensor;

5 first and second lead layers connected to the read sensor;

nonmagnetic insulative first and second read gap layers with the read sensor and the first and second lead layers being located between the first and second read gap layers;

10 ferromagnetic first and second shield layers with the first and second read gap layers being located between the first and second shield layers;

the first read gap layer having a resistance  $R_{G1}$  between the first shield layer and one of the first and second lead layers and the second read gap having a resistance  $R_{G2}$  between the second shield layer and said one of the first and second lead layers;

15 a connection via a plurality of resistors between a first node and each of the first and second shield layers wherein the plurality of resistors includes at least first and second resistors  $R_{S1}$  and  $R_{S2}$  and the first node is connected to said one of the first and second lead layers;

a second node located between the first and second resistors  $R_{S1}$  and  $R_{S2}$ ; and

20 an operational amplifier having first and second inputs connected to the first and second nodes respectively so as to be across the first resistor  $R_{S1}$  and an output connected to the first node for maintaining the first and second nodes at a common voltage potential.

25 2. A combination as claimed in claim 1 wherein the sensor and the first and second resistances  $R_{S1}$  and  $R_{S2}$  are coplanar.

3. A combination as claimed in claim 1 including:

30 a test instrument for enabling a determination of resistance having a first side connected to the first node and a second side connected to at least one of the first and second shield layers.

4. A combination as claimed in claim 3 including:  
the first and second shield layers being shorted together; and  
the second side of the test instrument being connected to each of the first and second shield layers.

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5. A combination as claimed in claim 4 wherein the sensor and the first and second resistances  $R_{S1}$  and  $R_{S2}$  are coplanar.

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6. A combination as claimed in claim 5 further comprising:  
a write head which includes:

a write head including:

ferromagnetic first and second pole piece layers that have a yoke portion located between a pole tip portion and a back gap portion;

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a nonmagnetic write gap layer located between the pole tip portions of the first and second pole piece layers;

an insulation stack with at least one coil layer embedded therein located between the yoke portions of the first and second pole piece layers; and

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the first and second pole piece layers being connected at their back gap portions.

7. A combination as claimed in claim 6 wherein the second shield layer and the first pole piece layer are a common layer.

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8. A combination as claimed in claim 6 wherein the second shield layer and the first pole piece layer are separate layers; and

a nonmagnetic insulative isolation layer located between the second shield layer and the first pole piece layer.

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9. A combination as claimed in claim 1 including:

the second resistor  $R_{S2}$  being connected between the second node and the second shield layer; and

5 a third resistor  $R_{S3}$  being connected between the second node and the first shield layer.

10. A combination as claimed in claim 9 wherein the sensor and the first, second and third resistances  $R_{S1}$ ,  $R_{S2}$  and  $R_{S3}$  are coplanar.

10 11. A combination as claimed in claim 9 including:

a test instrument for enabling a determination of resistance having a first side connected to the first node and a second side connected to the first shield layer.

15 12. A combination as claimed in claim 11 wherein the sensor and the first, second and third resistances  $R_{S1}$ ,  $R_{S2}$  and  $R_{S3}$  are coplanar.

13. A combination as claimed in claim 12 further comprising:

a write head which includes:

a write head including:

20 ferromagnetic first and second pole piece layers that have a yoke portion located between a pole tip portion and a back gap portion;

a nonmagnetic write gap layer located between the pole tip portions of the first and second pole piece layers;

25 an insulation stack with at least one coil layer embedded therein located between the yoke portions of the first and second pole piece layers;

and

the first and second pole piece layers being connected at their back gap portions.

30 14. A combination as claimed in claim 9 including:

a test instrument for enabling a determination of resistance having a first side connected to the first node and a second side connected to the second shield layer.

15. A combination as claimed in claim 14 wherein the sensor and the first, second and third resistances  $R_{S1}$ ,  $R_{S2}$  and  $R_{S3}$  are coplanar.

16. A combination as claimed in claim 15 further comprising:

5 a write head which includes:

a write head including:

ferromagnetic first and second pole piece layers that have a yoke portion located between a pole tip portion and a back gap portion;

10 a nonmagnetic write gap layer located between the pole tip portions of the first and second pole piece layers;

an insulation stack with at least one coil layer embedded therein located between the yoke portions of the first and second pole piece layers; and

15 the first and second pole piece layers being connected at their back gap portions.

17. A method of making comprising the steps of:

making a read head including the steps of:

forming a read sensor;

20 forming first and second lead layers with the first and second lead layers connected to the read sensor;

forming nonmagnetic insulative first and second read gap layers with the read sensor and the first and second lead layers located between the first and second read gap layers;

25 forming ferromagnetic first and second shield layers with the first and second read gap layers located between the first and second shield layers and the first read gap layer having a resistance  $R_{G1}$  between the first shield layer and one of the first and second lead layers and the second read gap having a resistance  $R_{G2}$  between the second shield layer and said one of the first and second lead layers;

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forming a connection via a plurality of resistors between a first node and each of the first and second shield layers wherein the plurality of resistors includes at least first and second resistors  $R_{G1}$  and  $R_{G2}$ , the first node is connected to said one of the first and second lead layers and a second node is located between the first and second resistors  $R_{S1}$  and  $R_{S2}$ ; and

connecting first and second inputs of an operational amplifier to the first and second nodes respectively so as to be across the first resistor  $R_{S1}$  and connecting an output of the operational amplifier to the first node for maintaining the first and second nodes at a common voltage potential.

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18. A method of making as claimed in claim 17 including making the sensor and the first and second resistances  $R_{S1}$  and  $R_{S2}$  coplanar.

19. A method of making as claimed in claim 18 wherein the step of making the sensor and the first and second resistances  $R_{S1}$  and  $R_{S2}$  coplanar includes the steps of:

simultaneously depositing a single layer of material for the sensor and the first and second resistances  $R_{S1}$  and  $R_{S2}$ ; and

simultaneously patterning said single layer of material to form the sensor and the first and second resistances  $R_{S1}$  and  $R_{S2}$ .

20. A method of making as claimed in claim 17 including:

connecting a first side of a test instrument for enabling a determination of resistance to the first node and connecting a second side of the test instrument to at least one of the first and second shield layers.

21. A method of making as claimed in claim 20 including:

shorting the first and second shield layers together; and

connecting the second side of the test instrument to each of the first and second shield layers.

22. A method of making as claimed in claim 21 including making the sensor and the first and second resistances  $R_{S1}$  and  $R_{S2}$  coplanar.

23. A method of making as claimed in claim 22 wherein the step of  
5 making the sensor and the first and second resistances  $R_{S1}$  and  $R_{S2}$  coplanar includes the steps of:

simultaneously depositing a single layer of material for the sensor and the first and second resistances  $R_{S1}$  and  $R_{S2}$ ; and

simultaneously patterning said single layer of material to form the sensor and  
10 the first and second resistances  $R_{S1}$  and  $R_{S2}$ .

24. A method of making as claimed in claim 23 further comprising the steps of:

making a write head including the steps of:

15 forming ferromagnetic first and second pole piece layers with a yoke portion between a pole tip portion and a back gap portion;

forming a nonmagnetic write gap layer between the pole tip portions of the first and second pole piece layers;

forming an insulation stack with at least one coil layer embedded  
20 therein located between the yoke portions of the first and second pole piece layers; and

connecting the first and second pole piece layers at their back gap portions.

25 25. A method of making as claimed in claim 24 wherein the second shield layer and the first pole piece layer are formed as a common layer.

26. A method of making as claimed in claim 24 wherein the second shield layer and the first pole piece layer are formed as separate layers; and

30 forming a nonmagnetic insulative isolation layer between the second shield layer and the first pole piece layer.

27. A method of making as claimed in claim 17 including:  
the second resistor  $R_{S2}$  further being connected between the second node and  
the second shield layer; and  
connecting a third resistor  $R_{S3}$  between the second node and the first shield  
5 layer.

28. A method of making as claimed in claim 27 including making the  
sensor and the first, second and third resistances  $R_{S1}$ ,  $R_{S2}$  and  $R_{S3}$  coplanar.

10 29. A method of making as claimed in claim 28 wherein the step of  
making the sensor and the first, second and third resistances  $R_{S1}$ ,  $R_{S2}$  and  $R_{S3}$  includes  
the steps of:

simultaneously depositing a single layer of material for the sensor and the first,  
second and third resistances  $R_{S1}$ ,  $R_{S2}$  and  $R_{S3}$ ; and

15 simultaneously patterning said single layer of material to form the sensor and  
the first, second and third resistances  $R_{S1}$ ,  $R_{S2}$  and  $R_{S3}$ .

30. A method of making as claimed in claim 27 including:  
connecting a first side of a test instrument for enabling a determination of  
20 resistance to the first node and connecting a second side of the test instrument to the  
first shield layer.

31. A method of making as claimed in claim 30 including making the  
sensor and the first, second and third resistances  $R_{S1}$ ,  $R_{S2}$  and  $R_{S3}$  coplanar.

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32. A method of making as claimed in claim 31 wherein the step of  
making the sensor and the first, second and third resistances  $R_{S1}$ ,  $R_{S2}$  and  $R_{S3}$  includes  
the steps of:

simultaneously depositing a single layer of material for the sensor and the first,  
30 second and third resistances  $R_{S1}$ ,  $R_{S2}$  and  $R_{S3}$ ; and

simultaneously patterning said single layer of material to form the sensor and  
the first, second and third resistances  $R_{S1}$ ,  $R_{S2}$  and  $R_{S3}$ .

33. A method of making as claimed in claim 32 wherein the second shield layer and the first pole piece layer are formed as a common layer.

34. A method of making as claimed in claim 32 wherein the second shield layer and the first pole piece layer are formed as separate layers; and  
5 forming a nonmagnetic insulative isolation layer between the second shield layer and the first pole piece layer.

35. A method of making as claimed in claim 27 including:  
10 connecting a first side of a test instrument for enabling a determination of resistance to the first node and connecting a second side of the test instrument to the second shield layer.

36. A method of making as claimed in claim 35 including making the  
15 sensor and the first, second and third resistances  $R_{S1}$ ,  $R_{S2}$  and  $R_{S3}$  coplanar.

37. A method of making as claimed in claim 36 wherein the step of making the sensor and the first, second and third resistances  $R_{S1}$ ,  $R_{S2}$  and  $R_{S3}$  includes the steps of:  
20 simultaneously depositing a single layer of material for the sensor and the first, second and third resistances  $R_{S1}$ ,  $R_{S2}$  and  $R_{S3}$ ; and  
simultaneously patterning said single layer of material to form the sensor and the first, second and third resistances  $R_{S1}$ ,  $R_{S2}$  and  $R_{S3}$ .

25 38. A method of as claimed in claim 37 wherein the second shield layer and the first pole piece layer are formed as a common layer.

39. A method of making as claimed in claim 37 wherein the second shield layer and the first pole piece layer are formed as separate layers; and  
30 forming a nonmagnetic insulative isolation layer between the second shield layer and the first pole piece layer.